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On Bond Mutual Funds participation in the Lending Market

Eduardo Miguel Baptista Gameiro

Work Project Carried out under the supervision of:

Melissa Prado & Emanuelle Rizzo

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Abstract

The purpose of this master thesis is to examine which factors drive the decision of bond funds to lend their securities and the performance of those funds which lend relative to similar funds which do not. Overall, none of the variables studied impact the decision of funds to lend securities, and funds which lend perform similarly to non-lending funds. To further clarify the dependency of the return-lending attribute, funds were divided according to the permanent or non-permanent character of lending practices. Funds that alternate between lending and non-lending exhibited a small albeit negligible return penalty.

Keywords: Bond mutual funds; bond lending; fund participation; entry variables

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List of Acronyms

FSOC	Financial Stability Oversight Council
ISLA	International Security Lending Association
IT	Information Theory
MIFID II	Markets in Financial Instruments Directive (recast) – Directive 2014/65/EU of the European Parliament and of the Council
NAV	Net Asset Value
QR	Quarterly Return
SEC	Securities & Exchange Commission
std	Standard Deviation

1. Introduction

1.1. Objectives

The objective of this thesis is to ascertain the main differences between the bond mutual funds that operate in the bond lending market and the bond mutual funds which do not. In addition to that the thesis quantitatively determines if there are differences in how the two sets of bond mutual funds fare.

1.2. Framework

The Financial Stability Oversight Council (FSOC), in its 2019 annual report (FSOC, 2019) estimated the value of securities lending transactions to be $2.4 trillion globally with the US carrying a 55% share of that market. Of the total global market, the FSOC estimates 43% can be accounted by equities and 45% by government securities, leaving corporate bonds and others an about 10% share of the market. These numbers agree with the International Securities Lending Association (ISLA) which reports (ISLA, 2019) the market at about €2.3 trillion ($2.5 trillion). Securities lending being comprised of 46% government bonds, 43% equities, and 10% corporate bonds. The International Security Lending Association (ISLA, 2019) report goes further, stating mutual and retail funds account for 46% of the supply and 18% of the demand for security lending; pension plans 19% and 29%, respectively; and government central entities and sovereign banks 6% and 14%.

What is also indisputable, however, is that the securities lending market is globally significantly smaller than it was in the pre-financial crisis. Despite the global bond and equities markets in most situations having surpassed their pre-crisis levels, the market of securities lending amasses far smaller levels than in the past. A report (SEC, 2019) from the Securities & Exchange Commission (SEC) for the third quarter of 2009 shows that

the global value of security lending decreased from $4.8 trillion in 2007 to $2.5 trillion in late 2008, and as can be seen from the above reports the value of the market in 2008 is undoubtedly the closest to the current valuation. Furthermore, the market seems a lot more geographically concentrated, as the global market share of the US in 2007 was then a lot smaller at 12% in comparison to today's 55% (SEC, 2019).

One major reason for this decline in the size of the market seems in part to have been the increase in regulation surrounding security lending. In what regards bond lending, there were since the crisis many new regulatory measures introduced. Offering the EU as an example: there was an introduction of a compulsory central counterparty clearing for all bond lending trades across EU countries, thereby introducing a new intermediary; the introduction of Markets in Financial Instruments Directive (recast) (Mifid II) requiring agency lenders to show regulators that they have executed each trade in the best possible manner on behalf of their clients; and the Securities Financing Transactions Regulation requiring borrowers and lenders to report each trade to a data repository by the end of the day as well as the reception of collateral by the following day, only this new regulation establishes 140 new different fields needing to be checked and answered to.

Thus, from such direct new regulatory pressures on bond funds one can hypothesize that the market is not as able to take care of small lenders whose small economies entail many new regulations will carry a heavy cost. As such, bond funds from larger fund families will probably be more interested in entering the market.

Since the design of the lending market seems highly beneficial to larger players, and economies of scale have been found in bond mutual funds, we should hypothesize that funds from larger fund families have a higher preponderancy to enter the lending market as they may see higher returns than ones from smaller families.

Nevertheless, bond mutual funds generally do not earn the same amount of revenue from lending bonds as equity mutual funds do from lending equities. The fact that the market largely exists is due to short selling, as naked short selling is not allowed in most exchanges, and since stocks are more volatile than bonds and bonds have a higher priority in case of a bankruptcy, there is generally a preference towards the shorting of equity as opposed to bonds.

Stock lending, by design, does indeed carry conventionally higher valuations when compared to bond lending, however, the bond lending market is also important, bond funds do represent a large portion of the lending market and can there can even arise situations where bond lending is an only path to follow. For instance, there could be an investor wanting to long one tier of the capital structure and short another; a credit spread arbitrage; a market-wide interest rate arbitrage; an arbitrage between a firm's bond and its CDS (or other securities reflecting credit quality); and borrowing a bond short-term to facilitate long trades whistle in the presence of temporary frictions in the delivery process. Lastly, there will be companies that have no publicly traded stocks but have bonds.

Therefore, and with all factors considered and extensively stated, one can conclude that even though bond mutual funds seem to benefit from economies of scale they will probably not gather as much profit from bond lending as their equity counterparts.

1.3. Organization of the document

The document is organized as follows. In section 2 entitled "Literature review and hypothesis development" the literature that is relevant to the thesis is reviewed to understand the important hypotheses on the decisions taken by bond mutual funds to enter the bond lending market. Then in section 3 "Data", we identify the quantitative data sources and detail the procedures used to manipulate the structure of the data so it was ready to be used in analysis.

In addition, this section also includes a statistical analysis of the data. In section 4 “Methodology”, we present the methods used to retrieve the information needed for the multivariate regression analysis. Then section 5 deals with the multivariate regression analysis where the final results are presented and discussed. In section 6, motivated by the need to understand if non-linear coupling blurs the results of linear regression analysis, we evaluate the mutual information between the performance and lending attribute variables. Finally, in section 7 we outline the main conclusions and outline some possible work that could follow.

2. Literature Review and Hypothesis Development

2.1. Short selling and Efficiency

In the previous sections we did not discuss if the lending market is efficiently priced or not. Given the short-selling constraints that exist, there is a strong case to be made that the market is priced inefficiently.

One of the first studies looking at the efficiency of prices is (Miller, 1977). In this paper the author argued that when short selling is constrained more pessimistic investors refrain from participating, leading prices to follow an optimistic model. Harrison and Kreps (1978) go even further by providing a dynamic model where the price of a security is driven above the valuation of the most optimist investor. Other authors e.g. Diamond & Verecchia, (1987) have argued differently, that short-selling constraints do not bias prices upward, but that they ultimately decrease the speed of adjustment and allow to achieve larger excess returns through the usage of public information. One may note an exception to this rule in Bai, Chang & Wang (2006) where the authors found that constraining short sales when they are driven by private information, can actually reduce the price of the asset as it increases the asset’s uncertainty and therefore decreases its demand.

Thus, it is an empirical question whether short sellers have abnormally high returns. Looking at the daily quantity of short selling Christophe, Ferri, and Angel (2004) ; Boehmer, Jones, and Zang (2008) ; Diether, Lee, and Werner Diether, K., Lee, (2009); Christophe, Ferri, and Hsieh (2010) (2010) ; Boehmer, Jones, and Zhang (2020) or looking at medium term data on short interest Karpoff and Lou (2010) , all find that short sellers possess private information and their trades generate abnormally high returns. Looking at the price of borrowing stocks Jones and Lamont (2002) ; D'Avolio (2002); Geczy, Musto, and Reed (2002); Ofek, Richardson, and Whitelaw (2004) find stocks with abnormally high rebate rates have future abnormally low returns. All in all, short sellers seem to be able to anticipate earnings surprises, financial misconduct, and analyst downgrades, confirming the hypothesis that the market presents prices that are too optimistic.

The literature examining the market for short selling of bonds is much less abundant. Among the few ones, one can mention, Nashikkar and Pederson (2007); Asquith, Au, Covert, and Pathak (2007). Asquith et al findings agree with the notion that short sellers can anticipate a major credit event such as a bankruptcy, though not completely. They also find that bond lending costs are tied to equity lending costs and like Nashikkar and Pederson (2007) find that bonds which have worse credit ratings, higher yield spread, smaller issue size, less time to maturity, and are less liquid and expensive relative to the corresponding credit default swap generally carry a higher specialness.

2.2. Interaction Between Bond Mutual Funds and the Short Selling Market

Since the two markets of borrowing equity and borrowing stocks appear to be tied and related Asquith et al (2007) found that bond short sellers also appear able to forecast future events one could hypothesize, as Evans, Ferreira, and Prado (2017) did for funds lending equities, that funds lending bonds may underperform similar funds in spite of lending income.

However, the literature on bond mutual fund performance is also sparse. In general, most literature agrees with the notion that bond mutual funds do not demonstrate superior performance net of expenses. Detzler (1999) using data spanning the years of 1988 to 1995 on a sample of funds gathered by Morningstar, found that returns seem to be even negatively correlated to fund expenses. In the paper from Chen, Ferson and Peters, (2010) the authors corroborate this statement by finding that though bond mutual funds outperform the market before expenses, they underperform it after expenses. Blake, Elton and Gruber (1993) even go to the conclusion that bond fund managers are generally totally ineffective at increasing risk-adjusted returns as one percentage point increase in expenses leads to a percentage point decrease in performance

Thus, from such conclusions we could expect that the funds that enter the lending market would at most be in par with non-lending funds and not exhibit a better performance. In fact, entering the market carries higher expenses which, in spite of an expected better managerial expertise, seems to have a negative correlation with profits. Moreover, short sellers also seem to possess private information enabling them to achieve abnormal returns. Similarly to the already referred paper of Evans, Ferreira, and Prado (2017) where the authors started with and verified the hypothesis of the short-sellers abnormally high returns, found that equity funds that entered the lending market exhibited an abnormally negative performance. However, other papers disagree, namely when it comes to bond fund performance. In the paper by Asquith et al (2007) we read that there is nothing abnormal in fund performance, as the authors find that the bond short sellers considered did not have abnormally strong performance, exhibiting negative returns which were almost the opposite of the market. The authors hypothesized the negative return to be consistent with short selling as a hedging activity with the short sellers paying the hedge. In another paper by Philpot, Hearth, Rimbey, & Schulman (2005) the authors concluded that, despite enjoying economies of scale, the past performance of a bond mutual

fund, unlike what happens with equity mutual funds, is not a good indicator for predicting the future fund performance. Therefore, from the last paper one could also reasonably hypothesize the performance after being in the lending market to be no different to the performance from before.

If this is so, this can disprove that bond funds which lend should underperform otherwise similar funds. Thus, it needs to be tested whether in the bond lending market such underperformance exists or not. However, outperformance among lenders is almost out of question, unless that outperformance is brought by another correlating factor such as the size of the fund.

Also of considerable importance is the explanation found by Evans, Ferreira, and Prado (2017) to justify why funds continue to lend securities despite knowing that short sellers possess private information and security lenders underperform non-security lenders. What the paper found was that funds that do security lending are on average more constrained compared to funds that do not lend securities. Imparting from a quote of Kevin Parke CEO of Massachusetts Financial Services, quoted in the referred paper, it appears to be true for some funds that their managers should stick to stocks even if they are out of favor and do not sell them to build a different portfolio. This may lead managers to get additional income through the lending of securities as they expect that for some time their portfolio will underperform.

Indeed, there are other papers that can give credibility to the statement that the presence of investment constraints is prejudicial for fund performance. Argawal, Boyson, and Naik (2009) find that mutual funds which implement hedge fund strategies outperform traditional mutual funds. Closer to our subject matter, Fabio Moneta (2015) finds that bond mutual funds which have a higher turnover rate have abnormally high returns.

Moreover, since high turnover bond mutual funds with lesser investment constraints seem to have higher returns it is important to add that another relevant factor for the entry into the lending market is turnover. High turnover funds generally restrain from entering the lending market as they may anticipate a greater number of loan recalls. Indeed, short sellers also prefer more passive funds like index funds; this arises not only from the risk of a recall, but also the fact that the median time taken to reestablish a short with a lender is nine trading days (D'Avolio, 2002).

In fact, in the US there is also a settlement lag of about three days on share lending contracts, meaning bonds must be delivered within three days after a sell. One can either locate the buyer first and then sell short or sell short and locate a buyer three days after a sell. Nevertheless, even if the settlement was successful it may have taken three business days to complete and in most countries the lags are even worse.

Therefore, we should divide bond mutual funds into passive and active bond mutual funds to see if indeed funds which more closely follow indexes are more likely to lend bonds as opposed to those which are actively managed. However, from already mentioned Fabio Moneta (2015) turnover or, in this case, a fund's lending status could also be correlated to the study variable performance. This is something we need to be careful as it may outweigh the value of the study variable.

A final matter of interest is pricing impact. As discussed by Rizova (2011) and Rowley et al (2016) a fund may not want to lend because doing so may create market disinterest. This is because the market may perceive the fund's lending as a bearish signal indicating that the security, or in this case, bond, will not have satisfactorily enough returns for the fund managers in the future. Thus, it is important to see if the funds that have a higher rate of ownership for the securities they invest in do refrain from lending.

In agreement with this view Prado, Saffi, and Sturgess (2016) find that stocks with more concentrated fund ownership have greater borrowing costs, higher recall risk, and increased levels of arbitrage risk. More particularly, the paper found both the concentration of fund ownership and the type of ownership, if active or passive, seem to provide relevant information on short-selling supply.

To test for the impact of pricing in the entry of funds we could follow Rizova (2011), and have a variable which interacts a fund's investment ratio in bonds of companies with small and medium capitalization with the total amount of assets a fund has. The comparatively higher the fund scores in that variable the more concentrated its bond ownership should be. However, the best decision, while also regarding the data available, seems to be to simply test if the performance of a bond mutual fund after entry in the bond lending market is lower.

If the performance does not decline meaningfully, one can conclude that the effect of the pricing impact is irrelevant. If however the performance of bond mutual funds decreases significantly then pricing impact cannot be discarded.

2.3. Additional Aspects: Economies of Scale

As mentioned in the introduction there is a strong case to be made for the presence of economies of scale. One important point unmentioned is the common use of a custodian involved to facilitate this transaction. The owner of the bonds would lend them to a custodian who would then find a willing short seller. The custodian will generally split the fees 25% to himself and 75% to the owner of the bond, but these numbers can change a lot depending on the conditions. These fees are generally heftier for smaller parties than they are for larger. Indeed, Duffie, Garleanu and Pedersen, (2002) and (2005) have argued that less connected borrowers often find themselves unable to arrange transactions to execute their trades, and in Rizova's Securities Lending by Mutual Funds (2011) splits

vary immensely, from 14% to the custodian and 86% to the lender to 50% for the custodian and 50% for the lender.

This issue can be explained by search frictions. This term was presented by Duffie et al. (2002) who constructed a dynamic model in which the frequency at which lenders and sellers were able to find one another was limited, to this opacity they gave the term search frictions. Only later did Kolasinski, Reed, and Ringgenberg (2013) find that search frictions significantly impact short-selling costs. An implicit conclusion that can also follow is that of Saffi and Sigurdsson (2011) who report lending agents prefer to work with larger security lenders.

However, because of the manner that search frictions operate, funds that have been in the market for a longer time may also be more knowledgeable and thus better able to acquire deals with custodians or if not through the use of a custodians they will probably be more noticeable in the market.

And pertaining solely to bond mutual funds, in a paper from Philpot, Hearth, Rimbey, and Schulman (2005) the authors have found that bond mutual funds unlike equity mutual funds enjoy economies of scale in their returns. Thus, if there are size advantages in the lending market such advantages should be even more perceptible in the results of bond mutual funds.

2.4. Final Remarks

Concluding this chapter in hypotheses development one can now explicitly write the different hypotheses to test for:

1. Does size affect the participation of a fund in the lending market;
2. Does being a passive or an active fund affect participation in that same market;

3. Are either the variance or annualized returns variables of interest in explaining fund participation in the lending market;

4. What is the exact impact on returns from being in the lending market;

5. Accounting for size, investment objective, and riskiness of returns, is the difference of returns from participating in the lending market now substantial?

3. Data

Under the Investment Company Act of 1940 (1940 Act), regulated funds including mutual funds and closed ended funds, and 1940 Act exchange-traded funds (ETFs) are required to disclose in their annual reports information pertaining to their lending activity.

Data was retrieved from Wharton Research Data Services (WRDS), more succinctly, the Center for Research in Security Prices (CRSP) database on mutual funds. The mutual funds from which data was retrieved were mutual funds which had their identification, in this case the CRSP fund number, reported in a document with data from NSAR filings which contained the proprietary information on whether those funds lent or not.

In line with the hypotheses discussed above the variables considered were Total Net Assets as of Month End, which by giving the total net asset value of the fund it is important in retrieving information for a study on the gains from scale of bond mutual funds. Another variable retrieved was Total Return per Share as of Month End which gives information on the performance of the fund, making it interesting for discerning not only if there is pricing impact on a fund but also how important past performance is for a fund entry. Also retrieved was the variable Index_fund_flag, which differentiating if a fund operates as an index fund or as an active fund. Lastly, a binary variable taking into consideration the Lipper Classification Code of a fund, that is, the investment objective of a fund, was produced. For funds which seem to follow a low risk

strategy the variable was given the value of 0, for funds which do not the variable was assigned a value of 1.

Since the dates shown on CRSP are not the same dates as the ones shown on the document with proprietary data, an extensive process to retrieve a common date for analysis was undertaken. First for each fund the difference between CRSP's date and the closest date shown on the NSAR filing was calculated. The dates on the document tell us if from 6 months prior to the date to the date shown the fund was either lending or not lending, thus when retrieving the closest date from CRSP to NSAR's date it is not a problem if the CRSP date is an earlier date, as long as the difference is less or equal to 6 months. As such, the procedure was first to check if the difference between the closest date on the CRSP and on the NSAR filing was higher than 3 months, if the difference is not higher than 3 months then dates will be matched at the date on the NSAR filings. If the difference is higher than 3 months we check if an earlier date to that on the NSAR filing exists that is no more than 6 months apart. If there is no such date, then the data is discarded.

After the data has been prepared the hypotheses can finally be quantitatively analyzed. Firstly, one starts by constructing tables with the participation rate of mutual funds in the lending market to see how the rate of participation changed within those years. As stated, from 2006 through 2016, the years through which we have data, participation rates should not substantially increase.

Also, likewise Evans, Ferreira, and Prado (2017) participation rates should be analyzed between active and index funds to see if a substantial difference in participation rate appears between either group, as stated in one of the hypotheses.

The first retrieved result was a table with a year by year (Table I) descriptive data on the evolution of funds that lend and funds that do not lend. As can be seen from 2008 to 2016, the

years where the amount of total funds is significant enough to be analyzed, the percentage of funds that do not lend significantly increased from about 48.40% to 71.63%. This was in line with expectations as regulations following the 2008/2009 economic recession made it harder for funds to lend bonds. All in all, in the greater part of the research there are between 312 and 712 bond funds for which data can be retrieved on the lending of bonds, which is satisfactory as total the dataset carries 791 bond mutual funds.

Table I Distribution of the funds used

	Total Number of Funds that Lend	Total Number of Funds that Lend	Total Number of Funds that do not Lend	% of Funds that Lend	% of Funds that do not Lend
2005	88	28	60	31.82%	68.18%
2006	312	161	151	51.60%	48.40%
2007	398	229	169	57.54%	42.46%
2008	564	294	270	52.13%	47.87%
2009	612	282	330	46.08%	53.92%
2010	629	241	388	38.31%	61.69%
2011	665	254	411	38.20%	61.80%
2012	691	234	457	33.86%	66.14%
2013	700	259	441	37.00%	63.00%
2014	699	234	465	33.48%	66.52%
2015	716	212	504	29.61%	70.39%
2016	712	202	510	28.37%	71.63%

It is also relevant to analyze fund lending by the type of fund, if active or passive as shown in Table II. Active funds that lend decreased significantly from 50.34% of those funds in 2006 to 27.69% in 2016. This decline was in line with the average fund, which should be expected since active funds are about 95% of total funds. Passive funds which lend also decreased very significantly from 92.86% to 42.42%. Overall, as expected, passive funds seem to be keener in participating in the bond lending market, however, since the number of passive funds is so low when compared to the number of active funds only regression analysis will be able to show if this is a significant result or not.

Table II Distribution of Active and Passive Funds

	Total Number of Active Funds	% of Active Funds that Lend	% of Active Funds that do not Lend	Number of Passive Funds	% of Passive Funds that do Lend	% of Passive Funds that do not Lend
2005	80	26.25%	73.75%	8	87.50%	12.50%
2006	298	49.66%	50.34%	14	92.86%	7.14%
2007	377	56.23%	43.77%	21	80.95%	19.05%
2008	540	50.93%	49.07%	24	79.17%	20.83%
2009	583	44.94%	55.06%	29	68.97%	31.03%
2010	601	37.10%	62.90%	28	64.29%	35.71%
2011	636	36.64%	63.36%	29	72.41%	27.59%
2012	662	34.59%	65.41%	29	17.24%	82.76%
2013	667	36.88%	63.12%	33	39.39%	60.61%
2014	666	33.03%	66.97%	33	42.42%	57.58%
2015	684	29.09%	70.91%	32	40.63%	59.38%
2016	679	27.69%	72.31%	33	42.42%	57.58%

Being the size of the fund, the variance of a fund's returns, the fund objective, and the passivity or activeness of a bond fund the variables of interest, it was also important to retrieve data on those variables in order to see if a fund which lends is substantially different from a fund which does not lend.

First, when calculating relevant data on the variables of interest it is important to know how many samples are in the dataset. As is shown in the columns of Table III there are 22 371 samples with 37.86% of them representing funds that lend and the rest funds that do not lend, very similar to the first table.

Table III Number of samples and lending characteristics

Number of Samples	22371
Number of Samples without Lending	13899
Number of Samples with Lending	8472
Probability of Lending	37.87%
Probability of not Lending	62.13%

From this dataset data was retrieved the logarithm of the net asset value (NAV) of funds. As can be seen in Table IV the average value of the logarithm of the net asset value is .981. There is also little difference between the value for the funds that lend (.972) and those that do not lend (.986). The variance however is lower in funds that lend and to funds that do not lend (.05). Using the standard deviation metric in order to calculate a 95% confidence interval, one can also recognize that both the expected log of Net Asset Value (NAV) for lenders (.5025 to 1.42) and non-lenders (.629 to 1.342) may be equal. One can even discard the hypothesis of a difference between the log of funds which lend and those that do not as the 95% confidence interval of funds that lend is entirely contained on the interval for funds which do not lend.

Table IV Statistics of Log Net Asset Value variable

Expected Log Net Asset Value	Expected Log of NAV for those which lend	Expected Log of NAV for those which do not lend
0.981	0.972	0.986
Variance of Log of Net Asset Value	Variance Log (NAV) knowing that it lends	VAR of Log (NAV) knowing it doesn't lend
0.039	0.050	0.032
Standard dev. of Log of NAV	Standard dev. of log (NAV) knowing it lends	Standard dev. of Log of NAV knowing doesn't lend
0.197	0.224	0.178
Expected Log NAV 95% Confidence Interval	Expected Log of NAV 95% Confidence Interval for lenders	Expected Log NAV 95% confidence interval for non lenders
.587 to 1.374	.5025 to 1.42	.629 to 1.342

From the second dataset, transcribed below, one can observe information for the quarterly performance of mutual funds (Table V). The average and expected performance for the funds in the dataset is of .014, and it is the same for funds that lend (.014) compared to funds that do not lend (.014). The variance of returns is also very low at an average value of .002, being equal to .001 for funds which lend and .002 for funds which do not lend. There is also a good chance the both the funds which lend and those which do not lend will have the exact same quarterly

return, with the confidence interval of the quarterly return for the first group ranging from -.066 to .088 and of the second group going from -.070 to .088. In fact, the confidence interval of the quarterly returns of funds which lend is entirely contained in the confidence interval of the funds which do not lend.

Table V Statistics of Quarterly Return Variable

Expected Quarterly Performance	Expected Q Performance for those which lend	Expected Q Performance for those which do not lend
0.014	0.014	0.014
Variance of Performance	Variance of Performance knowing it lends	Variance of Performance knowing it does not lend
0.002	0.001	0.002
Standard dev. of Q Perf	Standard dev. of Q Perf knowing it lends	Standard dev. of Q Perf knowing it does not lend
0.039	0.038	0.040
95% Confidence Interval for Q Performance	95% Confidence Interval for Q Performance knowing it lends	95% Confidence Interval for Q Performance knowing it does not lend
-0.065 to .092	-.063 to .090	-.066 to .093

For the binary variable (Table VI) characterizing if a fund engages in low risk investment strategy or not, with the value 1 being given for funds which do not engage in low risk investment and 0 being given for funds which do, the average binary value, shown below, is around .973 which means the vast majority of funds are, according to the criteria chosen, funds which do not engage in a low risk investment profile. Again, there is not a significant difference between those funds which lend (.970) and those funds which do not lend (.977). The variances are also similar, .029 and .022, thus the confidence interval will also be similar, .672 to 1.269 and .638 to 1.316. There does not seem to be any significance between the investment profile of any given fund and it choosing to lend bonds.

As stated, in order to calculate the value of one or zero of the binary variables characterizing the risk from the investment strategy of a given fund, the Lipper objective variable from WRDS

was used. The Lipper objective variable describes a fund's investment style. It has about 29 different qualitative values, but only short term US government funds (SUS), short to intermediate term US government funds (SIU), general US government funds (GUS), intermediate term US government funds (IUG), money market funds (MM) were considered to be low risk funds. This means that only 5 of the 29 different types of fund's were engaging in low-risk investment and were given a binary value of 0. This explains why the high value close to 1 that this binary variable has.

Table VI Statistics for the Risk variable

Expected Binary value	Expected Binary value for those which lend	Expected Binary value for those which don't lend
0.973	0.970	0.977
Variance of Binary	Variance of Binary knowing that it doesn't lend	Variance of Binary knowing that it lends
0.026	0.029	0.022
Standard deviation of binary	Standard deviation of binary knowing it lends	Standard deviation of binary knowing it doesn't lend
0.162	0.149	0.169
95% Confidence Interval for Expected Binary Value	95% Confidence Interval for Expected Binary Value for lenders	95% Confidence Interval for Expected Binary Value for non lenders
.649 to 1.291	.672 to 1.269	.638 o 1.316

Then comes the binary variable characterizing a fund follows an active or a passive strategy, with the value 1 being given for fund follows an active strategy and 0 if the fund follows a passive strategy, the average binary value is around .962 which means the vast majority of funds are active. Again, there is not a significant difference between those funds which lend (.974) and those funds which do not lend (.942). The variances are however different, .026 and .055, producing a confidence interval between .506 to 1.442 for funds which lend and of .622 to 1.262 for funds which do not engage in lending. Overall we can state that the fact that a fund lends or does not lend probably has no significant correlation with the fund being a passive or an active

fund, as the confidence interval of non-lender funds is entirely contained on the confidence interval of funds that lend.

Table VII Statistics for Active / Passive variable

Expected Binary value	Expected Binary value for those which lend	Expected Binary value for those which do not lend
0.962	0.974	0.942
Variance of Binary	Variance of Binary knowing that it doesn't lend	Variance of Binary knowing that it lends
0.037	0.026	0.055
Standard deviation of binary	Standard deviation of binary knowing it lends	Standard deviation of binary knowing it does not lend
0.192	0.234	0.160
95% Confidence Interval for Expected Binary Value	95% Confidence Interval for Expected Binary Value for lenders	95% Confidence Interval for Expected Binary Value for non-lenders
.578 to 1.338	.506 to 1.442	.622 o 1.262

When adding the variable variance of returns the number of samples decreases substantially to 9616, as shown in the table below. This is because there is the need to have both the last three variables and VAR coinciding in time which does not occur often. The percentage of funds which do not lend is now 60.80% and those that lend is 39.20%, thus not comparatively too different.

Table VIII Distribution of Funds When Adding Variance Variable

Number of Samples	9616
Number of Samples with Lending	3769
Number of Samples Without Lending	5847
Probability of not Lending	60.8%
Probability of Lending	39.2%

The variable VAR (Table IX) and its variance carry such low values that its variance is zero when approximating to the third decimal digit, both for funds that lend and funds that do not lend bonds. Nevertheless, when looking at the 95% confidence intervals, the first funds have a confidence interval ranging between -.016 to .024 and those which do not lend between

-.021 to .029. Therefore, it is not certain that with an alpha of .10 the variance of returns will be a significant variable to explain the lending decision of a fund.

Table IX Statistics for the Variance variable

Expected Variance	Expected Variance for those which lend	Expected Variance for those which do not lend
0.004	0.004	0.004
Variance of VAR	Variance of VAR knowing it lends	Variance of VAR knowing it does not lend
0.000	0.000	0.000
Standard dev. of VAR	Standard dev. of VAR knowing it lends	Standard dev. of VAR knowing it does not lend
0.012	0.014	0.012
95% Confidence Interval for VAR	95% Confidence Interval for VAR knowing it lends	95% Confidence Interval for VAR knowing it does not lend

4. Methodology

Following Rizova (2011) approach regressions can be drawn to see if being in the lending market affects the returns of a fund. Thus, a first regression would have as an independent variable the return of the fund and as dependent the lending status of that given fund. Nevertheless, there are other variables that can affect the return of a fund other than the lending status of a fund, so we keep adding variables that seem pertinent, such as the size of the fund, the investment objective of that fund, and the riskiness of returns.

Since have we described the main variables of interest, we can now conclude that the control variables, namely, the logarithm of net asset value, the active or passive binary variable, the fund's objective strategy, and the value at risk are not correlated to the main explanatory binary variable of a fund's lending. However, they can still be informative in explaining differences in our dependent variable, the fund's quarterly performance. Thus, regressions were drawn attending to that.

5. Multivariate Regression Analysis

The first regression takes the lending status of a fund as a sole variable to explain the fund's quarterly performance. The second regression adds to it the logarithm of the net asset value. A third regression adds a binary on the fund's active or passive status. Lastly, a fourth regression, albeit with less samples, adds the VAR of returns.

It can be inferred from the results of the first regression, as shown in the table below (Table X), that there is no significant relationship between quarterly return, the response variable, and lending status, the explanatory variable. The coefficient estimating the relationship between both variables is very close to zero and a t-value of -0.0042 is in this case insignificant.

Table X First Regression

Dependent Variable: Bond Mutual Fund Quarterly Return	
$LendingStatus_{t-1}$	-6.83E-06 (0.0016284)
N	22381
Adj R^2	-4.47E-05
SE Clustered by Year and Fund	Yes

In the second regression neither lending status nor the log of net asset value appear to be significant variables. Lending status carries a t-value of -.1602 and the log of net asset value a t-value of -1.35, both very insignificant, with p-values of .87 and .17 respectively. The second regression also carries an adjusted R^2 very close to zero with the added variables not able to explain almost anything of the variation in returns.

Table XI Second Regression

Dependent Variable: Bond Mutual Fund Quarterly Return	
$LendingStatus_{t-1}$	-2.67E-04
	(1.66E-03)
$LogofNAV_{t-1}$	-0.0165358
	(0.01227741)
N	22381
Adj R^2	6.57E-03
SE Clustered by Year and Fund	Yes

In the third regression shown herein, which adds the variable active or passive, also no significant variables were found. The most significant variable is again the log of net asset with a p-value of -.17 and the adjusted R^2 did not change compared to the previous regression.

Table XII Third Regression

Dependent Variable: Bond Mutual Fund Quarterly Return	
$LendingStatus_{t-1}$	-2.49E-04
	(1.67E-03)
$LogofNAV_{t-1}$	-0.01647
	(0.012068)
$ActiveorPassive_{t-1}$	0.000508
	(0.002758)
N	22381
Adj R^2	6.53E-03
SE Clustered by Year and Fund	Yes

Adding a fourth binary variable, risk, created from the Lipper fund objective also does not add relevant information, with the adjusted R^2 even decreasing compared to the one in the previous regression.

Table XIII Fourth Regression

Dependent Variable: Bond Mutual Fund Quarterly Return	
$LendingStatus_{t-1}$	-2.77E-04
	(1.67E-03)
$LogofNAV_{t-1}$	-0.01624
	(0.011924)
$ActiveorPassive_{t-1}$	0.00036
	(0.002691)
$Risk_{t-1}$	0.003915
	(0.002784)
N	22381
Adj R^2	9.15E-03
SE Clustered by Year and Fund	Yes

Adding the variance of returns, as expected, significantly increases the adjusted R^2 to .252. The variance of returns is generally highly correlated to total returns, the three asterisks in the table actually mean that the variable is significant to an alpha of less than 1%. However, by adding the variable VAR the total number of observations decreases from 22381 to 9616.

Table XIV Fifth Regression

Dependent Variable: Bond Mutual Fund Quarterly Return	
$LendingStatus_{t-1}$	-6.43E-04
	(2.36E-03)
$LogofNAV_{t-1}$	-0.0017
	(0.009261)
$ActiveorPassive_{t-1}$	-0.00068
	(0.002601)
$Risk_{t-1}$	0.003664
	(0.002122)
VAR_{t-1}	1.868511***
	(0.642605)
N	9616
Adj R^2	0.2524
SE Clustered by Year and Fund	Yes

One could state that the variable risk was an attempt to measure the impact of return variance without forfeiting on the amount of data lost by VAR. However, since we are using the variable VAR already in the regressions, we can remove the variable risk. This sixth regression, however, still shows no major significant variables other than VAR; and certainly not lending status which shows a p-value of .79.

Dependent Variable: Bond Mutual Fund Quarterly Return	
$LendingStatus_{t-1}$	-6.20E-04
	(2.36E-03)
$LogofNAV_{t-1}$	-0.00188
	(0.009274)
$ActiveorPassive_{t-1}$	-0.00027
	(0.002601)
VAR_{t-1}	1.869238***
	(0.642283)
N	9616
Adj R^2	0.2524
SE Clustered by Year and Fund	Yes

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6. Information Theory Based Checks

6.1. Quaterly return statistics conditioned to lending

Motivated by the absence of evidence about the influence the lending variable on the fund return, I looked at the possibility of still having information between the lending and return but in a non linear way that would not be recognized by the linear regressions or correlation metrics that focus om linear dependencies. To test that we considered the metric of mutual information between random variables from the Information theory (IT) field.

Although a presentation of the basic concepts of IT is not the purpose of this document we present the basic metrics in Appendix 2, while additional details and solid treatment can found in several textbooks (e.g. (Cover & Thomas, 1991)), it is worthy to point out some comments. With two random variable X and Y the covariance cov(X,Y), performs a weighted sum between samples of X and Y, that will be maximum (in modulus) when they are perfectly aligned and thus the aim is to confirm or infirm linear dependencies. The mutual information metric I(X,Y)

looks at what non-independence does to their joint probability distribution (which can be estimated). That is, I(X,Y) is the average value of the logarithmic measure of distance from independence. We may say that Mutual Information "is not concerned" whether the association between two variables is linear or not, while Covariance may be zero while the variables may still be dependent. On the other hand, the covariance can be calculated directly from a data sample without the need to actually know the probability distributions while for the mutual information either we know the distributions or have to apriori estimates by constructing histograms from the samples.

We used such concepts to understand how much related are the variables lending and quarterly return to check if the findings from statistical regression techniques are confirmed by IT. For a total of 9616 samples we computed: the main statistics for the variables; the quarterly returns histograms unconditioned and conditioned; The IT metrics (entropy and mutual information). For the IT metrics the probability functions for quarterly return (QR) were estimated using an histogram with 138 intervals (the value of 138 comes from the program sed that optimizes the number of intervals to smooth the estimates). The results are shown in Table XV.

Concerning the conditional averages and standard deviation (std), the values are quite similar either there is lending (variable equal to1) or not(variable equal to 0). The standard deviation turns to be quite high as we have significant tails in terms of return.

Concerning the IT metrics, the mutual information between the lending and quarterly returns is only 0.04bits for a total entropy of 4.45 bits in the quarterly returns. That is, with such a small mutual information it is clear that there is no significant non-linear dependency between these variables and therefore looking for regressions involving non-linear combinations of variables will probably be worthless.

Table XV IT metrics and statistics conditioned to lending

Statistic	Value
Average QR conditioned to lending=1	1,56%
Std QR conditioned to lending=1	4,08%
Average QR conditioned to lending=1	1,56%
Std QR conditioned to lending=0	4,46%
Entropy of lending variable	0,97 bits
Entropy of qr variable	4,45 bits
Entropy of joint distribution	5,37bits
Mutual Information	0,04 bits

6.2. Lending usage-based division of the samples

The regression analysis provided no evidence of dependence between the quarterly return and lending attribute of the fund. This finding was also confirmed through the computation of the mutual information between the variables.

Motivated by such issues we divided the funds in three classes to perform a further analysis. The mutual funds were in three different groups. The first group (class 0) includes the funds which participated for all samples in the lending market, the second group (class1) includes those which never participate, and a third group (class2) includes the funds which participated at some times and did not for other samples. The data is shown in Table XVI:

Table XVI Distribution of funds per class

Class	Number of funds	Number of samples
0	262	2924
1	107	1846
2	212	4846
Total	**581**	**9616**

We then retrieved the data on returns and standard deviation of those returns for these classes of funds, as is transcribed in the following table. As can be noted there is almost no difference between the average returns of the funds which always lend and those which never lend, neither between the standard deviations of the two groups of funds. The maximum and the minimum values found in the dataset were also relatively similar for both lenders and non-lenders. There was however a non-negligible difference in the average quarterly return of the mixed group of funds compared to the first two. While non-negligible this difference was nevertheless quite small when compared to the standard deviation. Using this classification of three categories the mutual information increases to 0.08 bits, which is still low but has increase relatively to the one obtained with only two classes. The results, that must be taken with caution, point out that funds that alternate between lending and non-lending suffer some penalty in terms of return through the alternate behavior.

Table XVII Statistics of return with three classes of funds

Class	Average Q. Return	Standard Deviation	Max Value	Min Value
0	1.72%	4.04%	26.39%	-29.22%
1	1.79%	4.29%	34.47%	-23.73
2	1.49%	4.48%	38.94%	-14.58%

7. Conclusion

The initial objective of the thesis was to check the impact and existence of clear relations between the lending activity and the performance / characteristics of mutual bond funds. An analysis was carried out using the statistical tools for regression. The main conclusion from this thesis is that there is no evidence of a difference between the fund characteristics of funds that have not entered in the securities lending market and those which did enter the market, at least as it relates to the size, performance, investment style of those funds, and variance of

returns. Bond mutual fund returns do not seem to be significantly affected by the size of a fund, by the investment style of a fund, and by the risk of a fund, as the regressions do not indicate any evident relation with the lending strategy. Motivated by this result, some work was performed using concepts from IT to check if there was some non-linear dependence that could not be caught by a linear analysis. Considering the IT metric of mutual information, we obtained a residual value which indicates that the low values obtained with regressions are not due to the lack of non-linear combinations of variables. To further clarify the dependency return-lending attribute, we divided the funds in three classes according to the permanent or non-permanent character of the lending decisions, and found that funds that alternate between lending and non-lending exhibit some return small but non-negligible penalty. These results have to be taken with caution as the standard deviations are quite high but may be worth to investigate more.

8. Appendix- Metrics in Information Theory

In Information theory the main concepts that emerge are:

1. **Entropy**: this represents the amount of intrinsic Information existing in a random variable i.e. the number of bits necessary to represent the outcomes of such variable (or pair of variables)

$$H(X) = -\sum_{x} p(x)\log\left(p(x)\ for\ \ a\ single\ variable X\right.$$

$$H(X,Y) = -\sum_{x,y} p(x,y)\log\left(p(x,y)\ for\ a\ bivariate\ (X,Y)\right.$$

2. **Conditional entropy**: represents the amount of uncertainty remaining in one variable *Y* after we know *X*

$$H(Y|X) = -\sum_{x,y} p(x,y)\log\left(p(y|x)\right.$$

3. *Mutual Information*: represents the information that is common to two variables *X* and *Y*.

$$\mathrm{I}(X,Y) = \sum_{x,y} p(x,y)\log\left(\frac{p(x,y)}{p(x)p(y)}\right)$$

In most cases the log is in base 2 and the units are in bits.

The mutual Information can be related to the bivariate and conditional entropies

$$I(X,Y) = H(Y) - H(Y|X) = H(X) - H(X|Y)$$

This can be illustrated graphically as shown in Figure 1.When $I(X,Y)=0$, there is no dependency between *X* and *Y*.

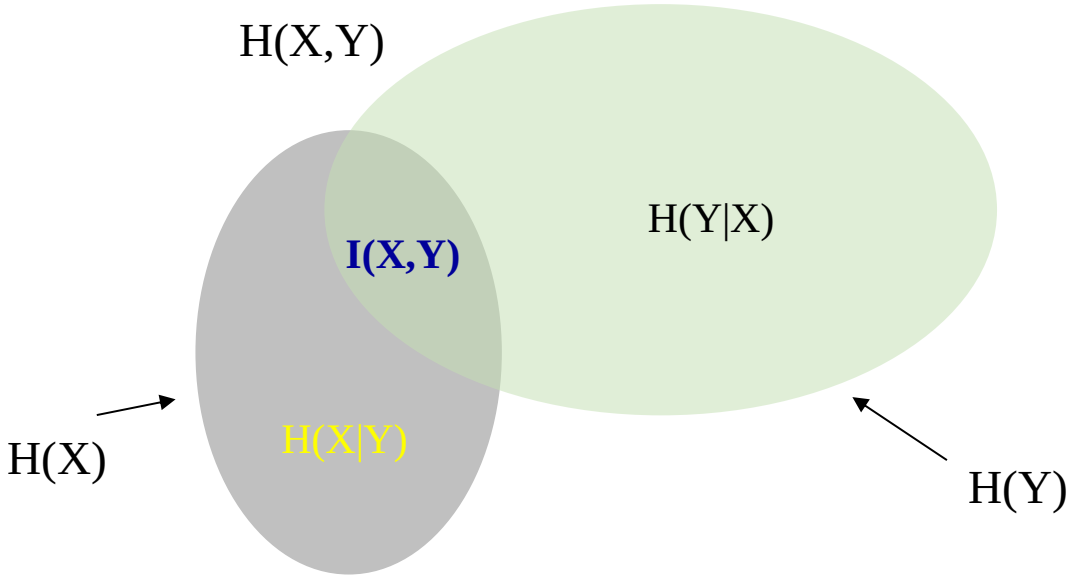

Figure 1 Relation between the different measures of information

9. References

Argwal, V., Boyson, N., & Naik, N. (April de 2009). Hedge Funds for Retail Investors? An Examination of Hedged Mutual Funds. *The Journal of Financial and Quantitative Analysis*, *44*(2), 273-305.

Asquith, P., Au, A., Covert, T., & Pathak, P. (August de 2007). The Market for Borrowing Corporate Bonds. *Journal of Financial Economics*, *107*. doi:DOI: 10.2139/ssrn.1631260

Bai, Y., Chang, ,. E., & Wang, ,. J. (2006). Asset Prices Under Short-Sale Constraints. Working Paper. Obtido de http://hdl.handle.net/10722/112142

Blake, C., Elton, E., & Gruber, M. (1993). The Performance of Bond Mutual Funds. *Journal of Business*, *66*(3), 370-403.

Boehmer, E., Jones, C., & Zang, X. (April de 2008). Which Shorts Are Informed? *The Journal of Finance*, *63*(2), 491-527.

Boehmer, E., Jones, C., & Zhang, X. (January de 2020). Potential Pilot Problems: Treatment Spillovers in Financial Regulatory Experiments. *Journal of Financial Economics, 135*(1), 68-87.

Chen, Y., Ferson, H., & Peter, H. (2010). Measuring the timing ability and performance of bond mutual funds. *Journal of Financial Economics, 98*(1), 72-89.

Christophe, S., Ferri, M., & Angel, J. (August de 2004). Short-Selling Prior to Earnings Announcements. *The Journal of Finance, 59*(4), 1845-1875.

Christophe, S., Ferri, M., & Hsieh, J. (January de 2010). Informed trading before analyst downgrades: Evidence from short sellers. *Journal of Financial Economics, 95*(1), 85-106.

Cover, T., & Thomas, J. (1991). *Elements of Information Theory.* John Wiley and Sons.

D'Avolio, G. (November de 2002). The Market for Borrowing Stock. *Journal of Financial Economics, 66*(2-3), 271-306.

Detzler, L. (1999). The Performance of Global Nond Mutual Funds. *Journal of Banking and Finance, 23*(8), 1195-1217.

Diamond, D., & Verecchia, R. (June de 1987). Constraints on short-selling and asset price adjustment to private information. *Journal of Financial Economics, 18*(2), 277-311.

Diether, K., Lee, K., & Werner, I. (February de 2009). It's SHO Time! Short-Sale Price Tests and Market Quality. *The Journal of Finance, 64*(1), 37-73.

Duffie, D., Garleanu, K., & Pedersen, L. (November de 2005). Over-the-Counter Markets. *Econometrica, 73*(6), 1815-1847.

Duffie, D., Garleanu, N., & Pedersen, L. (November-December de 2002). Securities lending, shorting, and pricing. *Journal of Financial Economics, 66*(2-3), 307-339.

Evans, R. F. (May de 2017). Fund Performance and Equity Lending: Why Lend What You Can Sell? *Review of Finance, 21*(3), 1093-1121.

FSOC. (2019).

FSOC. (2019). *Stability Oversight Council 2019 Annual Report.*

Geczy, C., Musto, D., & Reed, A. (2002). Stocks are Special Too: An Analysis of the Equity Lending Market. *Journal of Financial Economics, 66*(2-3), 241-269.

Harrison, J., & Krepps, K. (May de 1978). Speculative Investor Behavior in a Stock Market with Heterogeneous Expectations. *The Quaterly Journal of Economics, 92*(2), 323-336.

ISLA, I. S. (2019). *The Institutional Investor Guide to Securities Lending.* Obtido de https://www.isla.co.uk/wp-content/uploads/2019/03/ISLA_Industry_Guide_Institutional_Investor_September_19.pdf

Jones, C., & Lamont, O. (November-December de 2002). Short-sale constraints and stock returns. *Journal of Finantial Economics, 66*(2-3), 207-239.

Karpoff, J., & Lou, X. (October de 2010). Short Sellers and Financial Misconduct. *The Journal of Finance, 65*(5), 1879-1913.

Kolasinski, A., Reed, A., & M., R. (April de 2013). A Multiple Lender Approach to Understanding Supply and Search in the Equity Lending Market. *The Journal of Finance, 68*(2), 559-595.

Miller, E. (September de 1977). Risk, Uncertainty and Divergence of Opinion. *The Journal of Finance, 32*(4), 1151-1168.

Moneta, F. (2015). Measuring Bond Mutual Fund Performance with Portfolio Characteristics. *Journal of Empirical Finance, 33*(C), 223-242. doi:DOI: 10.1016/j.jempfin.2015.03.012

Nashikkar, A., & Pederson, L. (2007). Corporate Bond Specialness. *SSRN Electronic Journal*. doi:DOI: 10.2139/ssrn.967545

Ofek, E., Richardson, M., & Whitelaw, R. (2004). Limited arbitrage and short sales restrictions: evidence from the options markets. *Journal of Financial Economics, 74*(2), 305-342.

Philpot, J., Hearth, D., Rimbey, J., & Schulman, C. (2005). Active management, fund size, and bond mutual fund returns. doi:doi.org/10.1111/j.1540-6288.1998

Prado M., S. P. (2016). Ownership Structure, Limits to Arbitrage, and Stock Returns: Evidence from Equity Lending Markets. *" Review of Financial Studies, Society for Financial Studies, 29*(12), 3211-3244.

Rizova. (February de 2011). Securities Lending by Mutual Funds. *SSRN Electronic Journal*. doi:DOI: 10.2139/ssrn.2056651

Rowley Jr., J., Kahler, J., & Schlanger, T. (2016). *Impact assessment: Explaining the differences in funds' securities lending returns.* Obtido de Vanguard Research: https://personal.vanguard.com/pdf/ISGSLR.pdf

Saffi, P., & Siggurdsson, K. (March de 2011). Price Efficiency and Short Selling. *The Review of Financial Studies*(3), 821-852.

SEC, S. E. (2019). *Resetting the Roadmap: Managing in a New Securities Environment for Asset Holders.* Obtido de https://www.sec.gov/comments/4-590/4590-22.pdf